DOCUMENT RESUME

ED 309 963 SE 050 800

AUTHOR Enright, Brian E.; Connolly, Mary I.
TITLE A Research and Development Report on "The ENRIGHT Diagnostic Inventory of Basic Arithmetic Skills."
PUB DATE 6 Apr 89
NOTE 8p.; For a related paper, see SE 050 801.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Arithmetic; *Elementary School Mathematics; Elementary Secondary Education; Junior High Schools; *Mathematics Skills; *Mathematics Tests; Secondary School Mathematics; *Test Construction; Test Manuals; Test Reliability; Test Validity

ABSTRACT

The purpose of this paper is to report the research that took place during the development of the "ENRIGHT Diagnostic Inventory of Basic Arithmetic Skills." This is a criterion-referenced test designed to provide educators with information useful for changing instructional strategies based on known error patterns of students in grades 1 through 9. The Inventory is a group- or individually-administered 3-level system developed to minimize testing time. Each level narrows the area of interest until the critical skill is reached. The overall Inventory measures 144 sequentially ordered skills. This report describes the development procedure, which involved testing and studying approximately 7000 students over a 5-year period. The curriculum referencing component as well as the content validity, and subtest reliability studies conducted during the research are also described. The study as a whole led to the development of 233 error patterns that are descriptive of all predictable errors found in the research. The paper concludes with the descriptions of the three forms of information provided by the inventory: (1) computational skills competency; (2) analysis of error patterns; and (3) grade level information. (YP)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED309963

A

Research and Development

Report

on

The ENRIGHT® Diagnostic Inventory

of

Basic Arithmetic Skills

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☒ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Brian E. Enright

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

by

Brian E. Enright, Ed.D.
and
Mary I. Connolly

April 6, 1989

SE 050 800

A

Research and Development

Report

on

The ENRIGHT® Diagnostic Inventory of Basic Arithmetic Skills

by Brian E. Enright, Ed.D.

and

Mary I. Connolly

Introduction

The purpose of this paper is to report the research that has taken place during the development of the ENRIGHT® Diagnostic Inventory of Basic Arithmetic Skills.

The ENRIGHT® Diagnostic Inventory of Basic Arithmetic Skills is a criterion-referenced test designed to assess the various levels of arithmetic computation. The purpose of the instrument is two-fold:

a) to provide the user with information regarding student competency in arithmetic computation; and
b) to provide the user with specific information regarding the types of errors a student is performing on designated skills.

Thus, the purpose of the instrument is to provide educators with information useful to changing instructional strategies based on known error patterns.

The Inventory is a group or individually administered three-level system developed to minimize testing time. Each level narrows the area of interest until the critical skill (referred to as "point of impact") is reached. The overall Inventory measures 144 sequentially ordered skills.

Procedure

Research on the ENRIGHT® Diagnostic Inventory of Basic Arithmetic Skills (DIBAS) lasted approximately five years and included approximately 7,000 students. The students ranged from first grade to ninth grade and were from both special education, as well as regular classrooms. In the development of a criterion-referenced test, many aspects must be considered. Primary to research on any test instrument is the purpose for which the results will be used. As stated earlier, the purpose of this instrument is to provide current data regarding the status of a student's skills in arithmetic computation with potential for monitoring progress on an ongoing basis. Therefore, three considerations become meaningful to investigate:

a) the appropriateness of the skills being measured;
b) the accuracy of the items used to measure the skills; and
c) the consistency of the results.

To determine the degree to which the DIBAS meets these needs, three separate, yet related, studies were inaugurated. These studies were respectively:

a) a learner verification study;
b) a content validity study; and
c) a study of subtest reliability.

All three studies were designed to meet standards set by Hambleton and Eignor (1979).

Learner Verification

A learner verification study is one in which a first draft of a product is used extensively with students and feedback is gathered with regard to the results of this usage. In this specific study, data was gathered with regard to appropriateness of skills included, format, and error patterns identified by the Inventory. Continuous data was collected over a three-year period from approximately 150 teachers. Each teacher was required to use the Inventory with the students in his/her class. Each teacher then completed extensive questionnaires regarding usage, sequence of skills and the error patterns outlined in that draft. New skills were added; sequences of skills changed; and error patterns were altered and amended as a result of this study.

Additional information was gathered from this phase which led to the development of the 13 Skill Placement Tests later added to the Inventory.

Phase 2 of this study included 40+ educational diagnosticians and approximately 100 additional teachers. Phase 2 was built on the results of Phase 1 and emphasized the study of Error Patterns. The results of both phases resulted in the 233 Error Patterns found in the Inventory.

Curriculum Referencing

The 144 skills found in the DIBAS were cross-referenced to five Basal Series. The grade level at which each skill was introduced in each respective series, and the average grade level for each skill, were determined. The results of this referencing appear in Appendix C of the Inventory.

Validity

Two forms of validity were addressed in the development of the ENRIGHT® Diagnostic Inventory of Basic Arithmetic Skills.

- Content Validity

  There are 144 skills measured in the Inventory. To insure the content validity of the skill test, the skill items must measure their respective objectives and only those objectives. This process is known as Item Objective Congruence. The three-stage field test requiring a 90% agreement in Stages 1, 2 and 3 was designed to guarantee item congruence.

  ### Field Test

  Stage 1 - One hundred teachers in New Orleans, LA, were given copies of a first draft of the Inventory which was made-up of skill tests. The teachers used these tests in their classrooms for several months. Teachers then rated each item with reference to its appropriateness. A level of agreement of .90 was required for an item to be retained and used in Stage 2.

Stage 2 - Forty educational assessment specialists throughout the State of Louisiana were given a second draft of the Inventory which, by then, included error patterns. The skill tests were used in various settings for several months. The specialists critiqued the skill test for technical soundness and for appropriateness of the sequence of test items, the objective statements, and item objective match. The author required 90% agreement for the retention of test items.

Stage 3 - Finally, selected leaders in the field of educational assessment reviewed the Inventory. Again, the author required 90% agreement for the retention of test items and objectives.

Therefore, each item in the final Inventory went through three separate reviews and attained an item-objective congruence rating of .90 or better at each of the three reviews.

o Face Validity

The face validity of the Inventory should stand without question. The purpose of the test relates directly to arithmetic computation. The error patterns shown for each skill were established by analyzing the responses of thousands of students.

Reliability

Establishment of Reliability

The most fundamental criterion any test must meet is that it must be consistent in what it indicates about any person being tested; therefore, careful attention was paid to investigating the reliability of each section of the Inventory. The total instrument was not designed to be used at any one time; therefore, no total scores are available and no total test reliability coefficients were calculated. Instead, thirteen separate section reliabilities were calculated for the ENRIGHT® Diagnostic Inventory of Basic Arithmetic Skills using a split-half technique. N's between 80 and 100 were used for each section, with a total N of about 1170 used for the reliability testing. The reliability coefficients are presented in Table 1.

TABLE 1

Internal Consistency Reliability Coefficients

Section	Skill	Reliability Coefficient
A	Addition of Whole Numbers	.91
B	Subtraction of Whole Numbers	.98
C	Multiplication of Whole Numbers	.95
D	Division of Whole Numbers	.91
E	Conversion of Fractions	.95
F	Addition of Fractions	.94
G	Subtraction of Fractions	.94
H	Multiplication of Fractions	.91
I	Division of Fractions	.96
J	Addition of Decimals	.97
K	Subtraction of Decimals	.90
L	Multiplication of Decimals	.95
M	Division of Decimals	.95

Development of Error Patterns

A total of approximately 5,000 students were included in Stages 1 and 2 of the field testing. In Stages 1 and 2, the author was attempting to determine the kinds of errors that students make. Then, for two years, 2500 students were intensely studied to establish that these error patterns were consistent and representative. A total of five years of study led to the development of 233 error patterns that are descriptive of all predictable errors found in this research.

The author also found that the 233 error patterns could be grouped by common elements into seven significant error clusters. The seven error clusters into which all error patterns appear to fit are: regrouping, process substitution, omission, directional, placement, attention to sign, and guessing. The identification of error clusters assists the teacher in determining whether a student may be making the same error in different skill assessments. This could suggest a basic weakness in a fundamental arithmetic process. Also, the error cluster concept can assist the teacher in grouping and the selection of materials for instruction or remediation in the computational skill area.

Conclusion

The ENRIGHT® Diagnostic Inventory of Basic Arithmetic Skills provides educators with information regarding students' current status in arithmetic computation. It furnishes a means of tracking the student's competency in 144 basic arithmetic computation skills. Competency in these basic skills is necessary for advancement to higher skills in mathematics. The ENRIGHT® Diagnostic Inventory of Basic Arithmetic Skills provides three forms of information.

1. Computational skills competency.

   Each skill is measured using five items. Competency has been set at 80% accuracy (four to five correct). This accuracy has been set at this level to allow for random error. Random error should not occur consistently but usually reflects carelessness or a basic fact error.

2. An analysis of error patterns.

   An error pattern is a misstep in arithmetic computation that results in an incorrect answer. During the development and field testing of the Inventory, over 1000 different kinds of errors in computation were made by students. Analysis of these errors led to the formulation of 233 error patterns that are descriptive of all predictable errors found in the research. The 233 error patterns are grouped into seven error classes called clusters and they are clusters that consist of error patterns that have a significant element in common.

3. Grade level.

   Test referenced grade levels by publisher are included in each section of the ENRIGHT® Diagnostic Inventory of Basic Arithmetic Skills. Five widely-used basal mathematic series were analyzed to identify the level at which each of the 144 basic skills is presented. An average grade level was determined and can be found on the Examiner Page for each skill. Superscripts used throughout the Inventory indicate average grade level.

The Inventory was developed to be a complete arithmetic computation assessment and, at the same time, an efficient instrument. It is hoped that the Inventory will be administered by any diagnostician or classroom teacher interested in improving the quality of corrective instruction in his or her classroom.